NON-PUBLIC?: N
ACCESSION #: 9503200203
LICENSEE EVENT REPORT (LER)

FACILITY NAME: St. Lucie Unit 2 PAGE: 1 OF 7

DOCKET NUMBER: 05000389

TITLE: Manual Reactor Trip After Simultaneous Dropping of
Control Element Assemblies due to Equipment Failure
EVENT DATE: 05/21/93 LER #: 93-007-01 REPORT DATE: 03/16/95

OTHER FACILITIES INVOLVED: N/A DOCKET NO: 05000

OPERATING MODE: 1 POWER LEVEL: 072

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR SECTION:
50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:
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Technical Advisor

COMPONENT FAILURE DESCRIPTION:
CAUSE: B SYSTEM: AA COMPONENT: CON MANUFACTURER: C515
REPORTABLE NPRDS: Y

SUPPLEMENTAL REPORT EXPECTED: NO

ABSTRACT:

On May 21, 1993, St. Lucie Unit 2 was manually tripped from 72% power by utility-licensed operators approximately ten seconds after seven Control Element Assemblies (CEA's) fully inserted into the core. The dropped CEAs were confirmed by the presence of rod bottom lights, CEA reed switch position transmitter indication, and decreasing reactor coolant system average coolant temperature. Standard Post Trip Actions were carried out and the unit was placed in a stable condition in Mode 3.

Initial investigation revealed that several CEA power supply breakers were open and/or fuses blown which was indicative of an electrical fault. Subsequently, two grounded CEA cables associated with CEA's 54 and 61 were discovered in electrical penetration D-1 to the containment shield building. The root cause of the electrical grounds was investigated and could not be confirmed. However,a probable failure scenario is that

mechanical damage to the conductor's insulation occurred during the fabrication and/or installation of the conductor bundle.

Corrective Actions for this event: 1) Isolated grounded conductors in electrical penetration D-1 and relanded affected CEA cables to available spare penetration modules in penetration D-1, 2) Replaced the subgroup breaker associated with subgroup sixteen and individual disconnect breakers for CEA's 8, 54, 60, and 61, 3) Performed an Engineering Evaluation on multiple CEA drops and effects on Departure from Nucleate Boiling Ratio and Local Power Density which concluded that no Specified Acceptable Fuel Design Limits (SAFDL) were exceeded, 4) During the 1994 Unit 2 refueling outage, penetration D-1 was inspected, and the grounded modules were replaced. 5) A local leak rate test on penetration D-1 was performed with satisfactory results, and 6) The failed components were examined by the equipment vendor and an independent laboratory for root cause analysis.

END OF ABSTRACT

DESCRIPTION OF EVENT

On May 21, 1993, while Unit 2 was at 72% power steady state operation, control room operators observed the indication of multiple dropped Control Element Assemblies (CEA's) (EIIS : AA) on the Core Mimic Display and the CEA Display Panel accompanied by the simultaneous annunciation of alarm K-23 "CEDMCS (Control Element Drive Mechanism Control System) (EIIS: AA) Trouble". Subsequently, a decease in Tave was observed. The Digital Data Processing System indicated that the seven dropped CEAs were numbers 8, 54, 60, 61, 53, 65 and 67. Approximately 10 seconds after the CEA's dropped, operators manually tripped the reactor and the turbine in accordance with the immediate operator actions of the CEA Off-Normal procedure, ONOP 2-0110030. Emergency Operating Procedure (EOP) One, "Standard Post Trip Actions",was implemented immediately post-trip. The Steam Bypass Control System (EIIS: JI) operated properly to reduce Tave to 532 degrees Fahrenheit. The Steam Generators (SG's) (EIIS: AB) were supplied post trip via the Steam Generator Feed Pumps (SGFP) (EIIS: SJ) and the 15% feedwater bypass valve. After the successful implementation of standard post trip actions by two Reactor Control Operators, an uncomplicated reactor trip was diagnosed and the Senior Reactor Operator directed the crew to exit EOP-1 and enter EOP-2, "Reactor Trip Recovery". After the completion of EOP-2, the unit was maintained in Mode 3 for the post trip review and event investigation. Subsequent examination of the CEDMCS revealed the following conditions for the seven dropped CEA's: (See Figure One for an abbreviated schematic of the CEA power system)

- CEA 8, Regulating Group 5 - disconnect breaker was not tripped, no Subgroup fuses blown.
- CEA 54, Shutdown Group A - disconnect breaker was tripped.
- CEA 60, Regulating Group 3 (Subgroup 15) - disconnect breaker not tripped, no Subgroup fuses blown.
- CEA 61, Regulating Group 3 (Subgroup 16) - A&B phases of disconnect breaker tripped, 2 Subgroup fuses blown.
- CEA 63, Regulating Group 3 (Subgroup 16) - disconnect breaker closed, 2 Subgroup fuses blown.
- CEA 65, Regulating Group 3 (Subgroup 16) - disconnect breaker closed, 2 Subgroup fuses blown.
- CEA 67, Regulating Group 3 (Subgroup 16) - disconnect breaker closed, 2 Subgroup fuses blown.

CAUSE OF EVENT

The CEA power distribution system utilizes a 240 VAC three phase system with an ungrounded neutral line. This three phase AC is then rectified and conditioned by the CEDMCS to a nominal 50 VDC which is then supplied to each Control Element Drive Mechanism (CEDM) (EIIS: AA) coil stack inside of containment. During steady state conditions, the control room CEDMCS operating panel is switched to "Off", as its was during this event. This results in only the Upper Gripper Coil of each CEA being energized. If the Automatic CEDM Timer Module (ACTM) for a CEA reads an abnormal current condition for the Upper Gripper coil, the CEA will be maintained withdrawn by the ACTM energizing the Lower Gripper Coil. Under normal conditions, this DC power arrangement with an ungrounded neutral line is tolerant of at least one conductor short to ground. Furthermore, as long as the conductor grounds are of the same polarity, multiple conductor grounds on different coil stacks may not affect the system's operability and may go undetected. When a second conductor ground develops on a conductor of different polarity a short circuit develops which may cause CEDM coils to deenergize.

CAUSE OF THE EVENT (continued)

The most probable cause of the drop of seven CEAs is attributable to grounds in the 50 VDC CEDM power system located in an electrical penetration. Testing by the I&C Department revealed that five grounds were present in the Shield Building side of electrical penetration D-1. These conductor to ground shorts resulted in an overcurrent condition that opened the disconnect breaker for CEA 54, several contacts in the disconnect breaker for CEA 61, and the 2 fuses blown on subgroup 16. The

two CEAs which did not observe a condition that would permanently interrupt power to the Upper Gripper and Lower Gripper Coils were CEAs 8 and 60. (CEDM 60 was found to have a ground on the neutral phase of its load transfer coil; this condition alone would not cause the CEA to drop. CEDM 8 had no faults identified). The most likely cause for CEA's 8 and 60 to drop during this event was due to a transient induced on the CEDMCS 240 VAC power system when the conductor to ground faults developed. Output monitoring of the 2A Motor Generator (MG) set with a temporary power line monitor during testing of CEA 61 prior to the repairs showed that the grounds were reflected back throughout the CEDMC power system. This disturbance probably resulted in the dropping of CEA's 8 and 60.

The root cause of the conductor grounds in electrical penetration D-1 could not be determined immediately after the event since inspection of the penetration would require electrical penetration disassembly. Comprehensive testing of the CEDMCS, CEDM conductors, and the containment penetration provided a high degree of confidence in the operability of the systems required to support unit restart.

A detailed analysis of the conductor grounding was performed after the subsequent refueling outage which began in February, 1994. The Electrical Maintenance department, in conjunction with the original equipment manufacturer (OEM), removed and replaced the grounded feed through modules. The electrical penetration consists of two feedthrough assemblies, one for each side of the containment vessel wall with a transition splice area in the containment annulus. (See Figure Two) The faulted portion of the modules was at the connection of the feedthrough assembly to ground at the interior of the containment side module.

After an inconclusive onsite inspection, the two faulted feedthrough assemblies and a control assembly were then sent to the OEM for additional study. By August, 1994, the OEM could not identify any material deficiencies or the initiating cause of the faults. A complicating factor in the analysis was that the electrical arc over carbonized the fault sites and may have obliterated the material evidence for fault identification. An independent laboratory was then selected for additional analysis of the faulted and control assemblies. By January 1995, the independent laboratory could not identify any material deficiencies for the initiating cause of the faults.

Additionally, FPL Engineering performed testing on a mock up of the CEA drive equipment to determine system operating characteristics in an effort to determine root cause. The results from this testing did not provide insight for the root cause of the electrical failure. The NPRDS database was also reviewed; no similar failures were noted.

Therefore, root cause of the electrical penetration failure could not be determined. However, based on the location of the failure, a possible failure mode is mechanical damage to the insulation during

CAUSE OF THE EVENT (continued)

the fabrication and/or installation of the conductor bundle. A piece of contamination trapped between the conductor insulation and the module's tube sealant during manufacture could have damaged the insulation. This would have resulted in a localized area with low dielectric strength. If two adjacent conductors have similar types of damage, a hot spot and carbon tracking could develop with an increasingly conductive path forming over time. This scenario is supported by the location of the failures, the large amount of carbonization and thermal degradation found at the failure sites.

ANALYSIS OF EVENT

This event is reportable pursuant to 10CFR50.73(a)(2)(iv) as a manual actuation of the Reactor Protection System (RPS) (EIIS:JE). The supplement to this LER was expected to be submitted at an earlier date. However, due to the deferment of the refueling following this event and due to the multiple independent root cause analysis performed, the expected supplemental date was not met.

Having seven CEA's fully insert into the core during power operation is not specifically analyzed in the St. Lucie Unit 2 Final Updated Safety Analysis Report (FUSAR). Section 15.4.2.3.8 of the FUSAR analyzes a single dropped CEA as well as a dropped CEA subgroup. For a CEA subgroup insertion from 100% power, a calculated minimum Departure from Nucleate Boiling Ratio (DNBR) of 1.28 is reached in approximately 4 minutes with no operator action.

The Nuclear Engineering Department analyzed the seven dropped CEA's scenario and concluded that no DNBR or Fuel Design Limits were exceeded during this event. This evaluation was conservative in that it did not credit the immediate manual trip inserted by the operators. Additionally, no incore neutron detector alarms were received prior to the manual reactor trip; providing further assurance of remaining within core design limitations. The reactor trip was observed to be a routine manual trip. The resulting plant transient was well enveloped by the St. Lucie Unit 2 FUSAR.

Visual inspection and testing of electrical penetration D-1 did not

reveal any indication of containment integrity being affected by the conductor grounds. A precautionary local leak rate test was performed on penetration D-1 with satisfactory results, thus assuring that containment vessel integrity was not affected during this event.

Therefore, the health and safety of the public were not affected by this event.

CORRECTIVE ACTIONS

1) All CEDM cables were meggered through their respective penetrations which identified the five (three on CEA 54, one on CEA 61, and one on CEA 60) ground faults in penetration D-1 and to confirm that no other CEDM penetrations were affected.

2) Spare conductors in modules 20 and 24 of penetration D-1 were meggered to ensure that no faults existed prior to placing those spares in service. The grounded conductors in modules 11 and 17 of penetration D-1 were isolated and the affected CEA cables were reterminated to leads on the five available spares in modules 20 and 24.

CORRECTIVE ACTIONS (continued)

3) Pin to pin meggering was performed on the conductors in modules 11 and 17 of penetration D-1. This was to confirm that there were no conductor to conductor shorts within those modules for the conductors which were kept in service.

4) CEA Subgroup 16 breaker and the individual CEA disconnect breakers associated with CEAs 8, 54, 60, and 61 were replaced.

5) Using a power line condition monitor with the trip circuit breakers closed, satisfactory CEDM motor generator bus phase to phase and phase to ground voltage traces were recorded and reviewed to ensure that no faults existed on that power supply.

6) Nuclear Engineering has performed an analysis of multiple rod drops as experienced by this event to confirm that DNBR or Local Power Density safety limits were not violated.

7) To confirm the integrity of the fuel, Iodine levels in the RCS were monitored by Reactor Engineering and compared with previous values. No abnormal levels were noted.

8) A satisfactory Local Leak Rate test on penetration D-1 verified containment vessel integrity.

9) During the subsequent Unit 2 refueling outage, the grounded feedthrough modules and a non-grounded module were replaced by Electrical Maintenance and the equipment vendor to determine the root cause of the electrical grounds.

10) The failed electrical penetration components were sent off site for failure analysis by the equipment vendor. The vendor concluded that this was a random failure.

11) The failed electrical penetration components were subsequently sent to an independent laboratory for additional analysis. The laboratory could not confirm the root cause, but did hypothesize a failure scenario.

12) Instrumentation & Controls Maintenance will evaluate the dielectric strength of the CEA conductors in the RCB electrical penetrations by performing pin to pin and pin to ground resistance checks during the next two refueling outages for Unit 1 and Unit 2.

ADDITIONAL INFORMATION

Failed Component Identification

Component : Low Voltage Electrical Penetration
Manufacturer: CONAX Corporation Part Number: 7310-10004-07

Previous Similar Events:

See LER #389-89-007 and LER #335-80-050 (manual reactor trips due to multiple dropped CEA's)

Figure "FIGURE ONE - CEA POWER DISTRIBUTION" omitted.

Figure "FIGURE TWO - ELECTRICAL PENETRATION" omitted.

Florida Power & Light Company, P.O. Box
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March 16, 1995

FPL

L-95-085
10 CFR 50.73

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D. C. 20555

Re: St. Lucie Unit 2
Docket No. 50-389
Reportable Event: 93-07 - Revision 1
Date of Event: May 21, 1993
Manual Reactor Trip After the Simultaneous Dropping
of Control Element Assemblies Due to Equipment Failure

The attached Licensee Event Report is being revised pursuant to the requirements of 10 CFR 50.73 to provide an update on the subject event.

Very truly yours,

D. A. Sager
Vice President
St. Lucie Plant

DAS/EJB

Attachment

cc: Stewart D. Ebneter, Regional Administrator, USNRC Region II
Senior Resident Inspector, USNRC, St. Lucie Plant

an FPL Group company

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